Integrating Space Into Training Simulations

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LIEUTENANT Commander Pete McVety envisions a future Navy reliant upon light, highly versatile, unmanned aerial vehicles (UAVs) to perform remote sensing, act as communications relays, and function as attack platforms.[1] Because of today's emphasis on technology to increase the reach and capabilities of U.S. weapon systems, the U.S. Navy employs a mix of current and emerging technology. In fact, the space systems required to implement McVety's vision exist now—lightweight satellite communications (SATCOM) and global positioning system (GPS) receivers. Across the services, evolving command, control, communications, and intelligence (C3I) systems' reliance on space-based systems becomes increasingly transparent to operators but ever more critical to successfully operating those systems. Training commanders and operators to exploit the space capabilities supporting their C3I systems and to mitigate potentially debilitating degradations due to natural causes or threat activity is a progressive challenge as reliance on space becomes increasingly transparent.

Space applications at the operational level exploded into the Army's consciousness during the Persian Gulf War. Once seen as the domain of national capabilities, tactical commanders could exploit space products at an unprecedented level during that conflict. For example, it is difficult to overstate the impact of precision navigation that GPS receivers provide in the desert or their ability to detect and warn people of incoming Scud missiles. Recalling the near-revolutionary impact of GPS on maneuver warfare during the conflict, the official history records: "The appearance of GPS during Desert Shield obliged combat units to change tactics and operating procedures in order to realize the full potential of precision locating devices."[2] More recently in Kosovo, the U.S. Air Force used the multiple-source tactical system in the cockpit to provide crews unprecedented situational awareness by integrating GPS, SATCOM, and space-based sensors.[3]

Most of the space-based capabilities integrated into tactical units' day-to-day operational systems are not included in the simulations used for Army training. In short, commanders generally lack the opportunity to train units to work through the space systems degradation they are likely to experience during deployments or to fully exploit the space products available to them.

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Evolving Space Capabilities

Space operations officers are being trained and will form space support elements (SSEs) at corps and division levels. SSEs will provide unprecedented expertise to integrate and synchronize space within those units. Army space support teams (ARSSTs) from the U.S. Army Space Command supported corps commanders and their staffs for most of the past decade. The combination of a dedicated SSE and an ARSST manned by experienced space operators and deployed with specialized equipment will provide a robust, focused capacity to leverage both government and commercial space systems and organizations. Specifically, they will improve the space force enhancement aspect of space operations, defined as "any operation from space with the objective of enhancing, enabling, or supporting terrestrial operations in peacetime, conflict, and war."[4] Doctrinally, elements of force enhancement include communications, position and

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VII Corps elements deploying along Tapline Road, 11 February 1991. During the Gulf War, GPS allowed units to cross featureless desert terrain with absolute confidence.

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navigation, weather, terrain, environmental monitoring, and surveillance.[5] Theater missile warning is commonly included in this list as well.[6]

Exploitation of force enhancement elements has been aptly demonstrated in recent years, particularly during operations in the Balkans, and include bulk data transmission using the Global Broadcast Service (GBS) to predict space weather that affects satellite and terrestrial communications, and commercial high-resolution imagery. Beyond force enhancement is an emerging space capability known as "space control." Space control ensures the availability of space capabilities to friendly forces while denying it to the enemy.[7] Examples of specific activities include physically protecting ground facilities, jamming uplinks and downlinks of enemy systems, or denying commercial space services. This aspect of space operations is emphasized in U.S. Army Field Manual (FM) 3-0, *Operations*: "Although the U.S. may have an advantage in surveillance assets, commanders should assume that enemies also have adequate surveillance means. For example, an enemy may purchase high-resolution imagery from commercial spaced-based systems."[8]

Given this increased space operational capability available to corps commanders and potential threat forces, simulating existing and future space capabilities to the degree necessary to train at the corps and division levels becomes increasingly important. U.S. Army Regulation 5-11, *Management of Army Models and Simulations*, defines models and simulations as: "The development and use of live, virtual and constructive models including simulators, emulators, and prototypes to investigate, understand, or provide experimental stimulus to either (1) conceptual systems that do not exist or (2) real life systems which cannot accept experimentation or observation because of resource, range, security, or safety limitations. This investigation and understanding in a synthetic environment will support decisions in the domains of Research, Development, and Acquisition (RDA) and Advanced Concepts and Requirements (ACR), or transfer necessary experiential effects in the Training, Exercises and Military Operations (TEMO) domain."[9]

This article focuses on training simulations, specifically those simulations used in training at the U.S. Army corps level. For example, current simulations used by the Battle Command Training Program (BCTP) at Fort Leavenworth, Kansas, include the venerable Corps Battle Simulation (CBS) and the Brigade/Battalion Battle Simulation (BBS). Adapted, updated, patched, and expanded, CBS has been a mainstay for many years for training corps and division commanders and staffs. CBS also forms the core for the Joint Training Confederation used for joint staff training.[10] A complementary simulation for training at lower levels, BBS is designed to be a low-cost capability to train maneuver brigade and battalion commanders and their staffs.[11]

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Because it was developed before there were common space applications at the operational and tactical levels, CBS does not deliberately model space capabilities. For example, within CBS, unit location information reported to the training audience is actually ground truth. A scenario using GPS spoofing or jamming to achieve a stated training objective cannot be modeled within CBS because the simulation cannot readily deviate from reporting unit locations as actually maintained within the simulation without extensive manual interface. Likewise, "space effects" required to initiate a corps staff planning process by replicating an enemy with a credit card and Internet access are generally not replicated in current training simulations. Consider the potential of a Mohamed Aidid using the Internet to gain high-resolution commercial imagery in hours, to exploit GPS to rapidly move his forces, or to purchase commercial SATCOM systems and access. These kinds of scenarios must be created by using manual workarounds.

Converging Point—Bringing Together Space Operations and Simulations

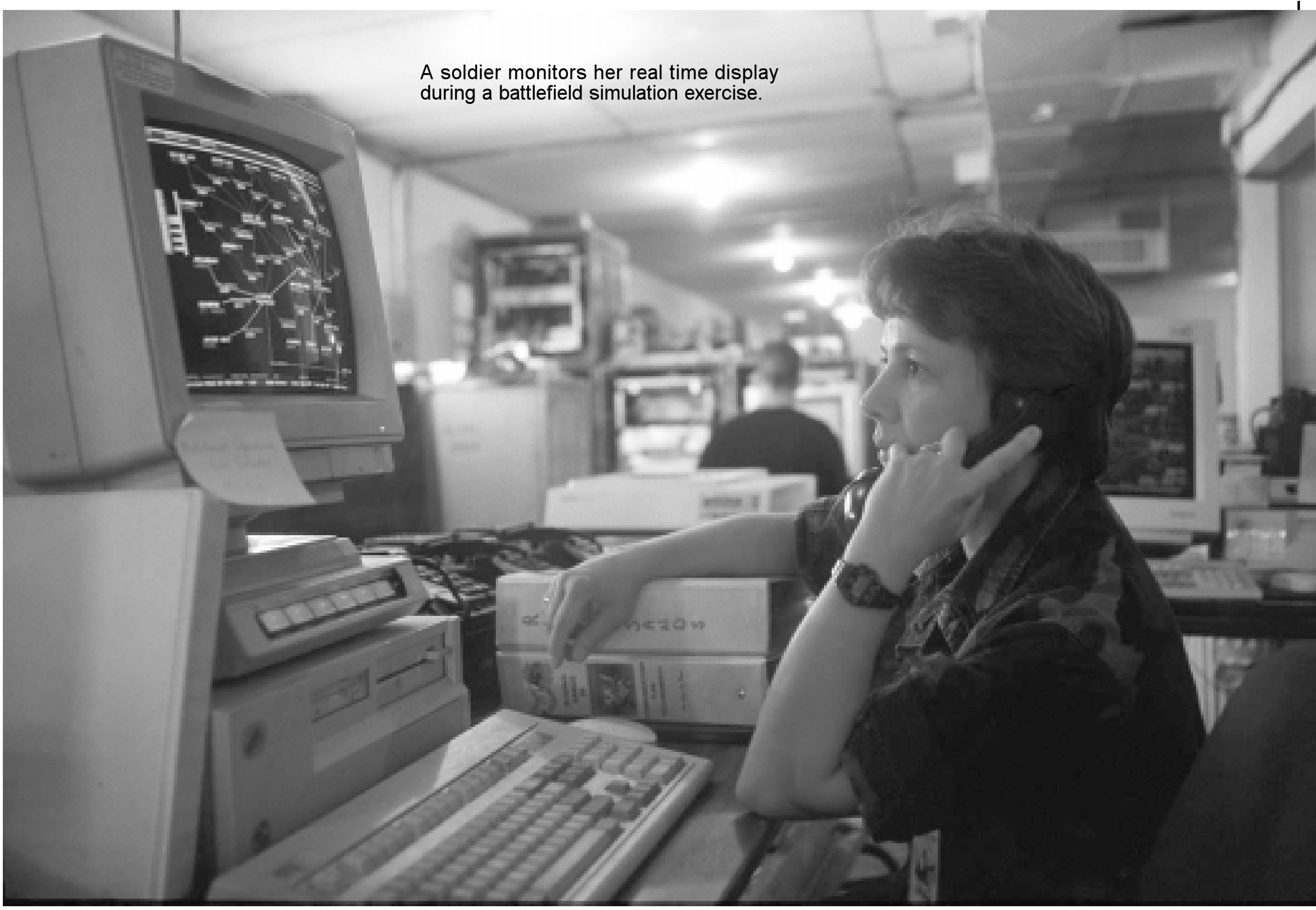
There are two challenges to integrating space scenarios into training simulations. First, manual integration processes usually require intensive and focused effort by a qualified team developing scripted inputs consistent with the commander's training objectives under an exercise director's control. Second, future simulations require true integration of space capabilities so that ground component commanders receive realistic effects—both positive and negative for operational decisions they make during exercises.

Space and current simulations. Currently, space integration into BCTP warfighter training exercises (WFXs) requires manually injecting space products and effects. To facilitate this process, The U.S. Army Space and Missile Defense Command (USASMDC) and BCTP executed a Memorandum of Agreement on 22 June 2001 that detailed specific activities and requirements for providing space effects during future WFXs. The focus of this effort is at corps level and includes a specialized space integration team that provides manual event inputs by using stand-alone models, when applicable, with descriptions of the desired effects and anticipated unit reactions, and an observer/controller. These capabilities are in addition to the capabilities provided by an ARSST and, when manned, the SSE located at the corps headquarters.

GPS location and timing are familiar capabilities to most and are, therefore, used here as an example of how a corps WFX manual workaround is injected. Accurate positions provided by GPS depend on the number of satellites in view of the GPS ground receiver. These satellites are susceptible to a number of space weather conditions. For example, atmospheric and ionospheric scintillation can cause GPS timing errors, and ionospheric scintillation can also cause GPS signal loss or positioning errors. A reduction in the number of satellites in view due to ionospheric scintillation will reduce accuracy. If a space weather prediction projects a specific impact on the GPS constellation during a deep attack that depends on GPS for precise navigation, that fact must be considered in deep strike planning. Consequently, the commander may require the SSE to project a period when GPS accuracy is not degraded.

GPS can be jammed, and effective jammers are available to those willing to pay for them. If a threat force is willing to sacrifice GPS accuracy to degrade friendly force capabilities, it may employ GPS jamming to desynchronize friendly actions or support a specific threat operation. The commander will depend on the SSE, in conjunction with the G2 and G6, to keep him informed of such situations and to recommend how to mitigate this threat.

During the WFX, the USASMDC team working with BCTP will identify potential space events consistent with the commander's training objectives and propose injects to the exercise director. A typical event might be to create a situation in which the threat would implement GPS jamming to degrade friendly force accuracy or GPS timing of communications systems, with a primary training goal of causing the corps staff to recognize the threat and respond.



A soldier monitors her real time display during a battlefield simulation exercise.

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As indicated earlier, CBS assumes perfect positioning in the simulation, thus it is unable to simulate the degraded accuracy of a perceived unit location vis-à-vis ground truth. This requires a manual workaround to affect the scenario, usually by text message, to develop the situation and to attain the training objective. This is but one example of a means to overcome simulation shortfalls to provide realistic training.

Not all exercises demand manual workarounds. Several excellent commercial or government-produced, stand-alone space models exist to perform various functions. These models include those that provide satellite orbital data, space-based radar, imaging, GPS accuracy and jamming, and missile launch detection. Exercise directors may federate and integrate some of these models to provide specific space capabilities within an operational demonstration or training event. The Mounted Maneuver Battle Lab's (MMBL's) future combat command and control experiment (FCC2) during May 2001 is a good example. During FCC2, the Space and Missile Defense Battle Lab linked several models to provide a space-based radar capability in support of future brigade operations. This diverse federation seamlessly integrated with the One Semiautomated Force (OneSAF) testbed, the overall simulation driver used by MMBL. The federation included an asset scheduler (to optimize satellite scheduling), Descriptive Intermediate Attributed Notation for Ada (to exploit synthetic aperture radar information), a moving target indicator version of virtual surveillance target attack radar (a joint surveillance target attack radar system emulator), and an overall model integrator. These linked models formed a distinct, compact sensor capability with variable time and accuracy reporting through a replicated ground station to representative command and control systems within the brigade. In this case, manual workarounds were virtually nonexistent because the federation interface with the simulation driver interacted automatically with the training audience.

Space integration in future simulations. During 1999, USASMDC established a team to build the foundation for integrating space into BCTP. Although the immediate focus was integrating space into warfighter simulation, the intent was to develop

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functional descriptions universally applicable to all future training simulations. The team uses the functional description of the battlespace (FDB) process. FDB is a research and development effort funded by the U.S. Army Training and Doctrine Command and managed by the Simulation, Training, and Instrumentation Command in conjunction with the National Simulation Center.[12] The FDB holds a repository of documents used by software engineers to develop future simulations consistent with the Army's organization; doctrine; and tactics, techniques, and procedures (TTP). Space FDB documents focus on activities of space operations officers in the corps SSE, but the document's focus will expand to include elements of the 1st Space Battalion (ARSST and the Joint Tactical Ground Station), U.S. Army Space Command, and generic space capabilities.[13] Specific examples include space weather effects on operations; availability and impact of commercial imaging for friendly, neutral, and threat forces; availability and accuracy of satellite orbital data; theater missile warning architecture; degradation; and SATCOM. All these documents describe space architectures in a way that a ground component simulation can integrate seamlessly with joint-level simulations describing the same capabilities. As they are developed, space subject matter experts can review the documents. However, it is important to remember that although simulations can be jointly integrated, they must describe an environment in which the ground commander's use of space products and effects of space on ground operation are faithfully replicated.

Most readers have seen film footage of pre-World War II soldiers training with cardboard-covered automobiles as tanks, sticks as machineguns, and metal tubes as antitank guns. In a sense, that is where the Army is today when it comes to space integration in current corps- and division-level simulation. Increasing operational dependence on space and growing availability of space products to potential adversaries demand realistic training for U.S. Army forces.

Greater reliance on simulations to create that training environment presents challenges and opportunities. Challenges in the near term include improvising manual workarounds and federating models so that commanders' immediate training objectives are achieved. Another challenge is educating commanders and staffs about space capabilities. Opportunities present themselves as trainers establish requirements for simulation-driven training environments. To ensure that low-technology training is not conducted amidst advanced command and control capabilities when attempting to train soldiers to exploit space, the Army must build space operations into future training simulations—simulations that cause positive or negative outcomes based on commanders' decisions. Soldiers must encounter the unexpected in training and not on the streets of a hostile city. ***MR***

NOTES

1. Lieutenant Commander Pete McVety, "An Unmanned Revolution," *Proceedings* (March 2000), 88.
2. Department of the Army, *Certain Victory: The US Army in the Gulf War* (Washington, DC: Office of the Chief of Staff, U.S. Army, 1993), 362.
3. General Richard B. Meyers, "Space Superiority is Fleeting," *Aviation Week and Space Technology* (1 January 2000), 54.
4. U.S. Army Space and Missile Defense Command, *Army Space Reference Text* (Huntsville, AL: April 2000), 27.
5. U.S. Army Field Manual (FM) 100-18, *Space Support to Army Operations* (Washington, DC: U.S. Government Printing Office [GPO], 20 July 1995), 14.
6. *Army Space Reference Text*, 27.
7. FM 100-18, 16.
8. FM 3-0, *Operations* (Washington, DC: GPO, 14 June 2001), 11-19.
9. U.S. Army Regulation 5-11, *Management of Army Models and Simulations* (Washington, DC: GPO, 10 July 1997).
10. National Simulation Center, *Training With Simulations, A Handbook for Commanders and Trainers* (Fort Leavenworth, KS: National Simulation Center, January 1999), 76.
11. Ibid, 65.
12. U.S. Army Combined Arms Center, *Annual Command History* (Fort Leavenworth, KS: U.S. Army Combined Arms Center, 1994), Chapter 4.
13. Space operations officer functions used to develop the functional description of the battlespace documents are drawn from the space operational architecture under development by USASMDC.

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